Citation:

Bourque C, St-Onge MP, Papamandjaris AA, Cohn JS, Jones PJ. Consumption of an oil composed of medium chain triacyglycerols, phytosterols, and N-3 fatty acids improves cardiovascular risk profile in overweight women. *Metabolism.* 2003 Jun; 52(6): 771-777.

PubMed ID: 12800105

Study Design:

Randomized Crossover Trial

Class:

A - Click here for explanation of classification scheme.

Research Design and Implementation Rating:

NEUTRAL: See Research Design and Implementation Criteria Checklist below.

Research Purpose:

- To test the hypothesis that consumption of medium chain triacylglycerols (MCT) along with phytosterols and n-3 polyunsaturated fatty acid (PUFA) would prevent undesirable increases in blood lipid concentrations and allow MCT use in prevention of weight gain
- To evaluate the effect of a diet supplemented with a functional oil (FctO) containing thermogenic MCT (50% of fat), cholesterol-lowering phytosterols (22mg per kg body weight) and triacylglycerol-suppressing *n*-3 fatty acids (5% of fat) vs. a beef tallow-based diet, on blood lipids as an indicator of cardiovascular disease (CVD) risk.

Inclusion Criteria:

- Female
- Body mass index (BMI) more than 25kg/m^2
- Total plasma cholesterol concentration 3.0mmol per L or less
- Total circulating triacylglycerol 3.0mmol per L or less
- Stable body weight (±5%) for at least three months before study entrance.

Exclusion Criteria:

- Existence of chronic illnesses including diabetes, hypertension, CVD, liver disease, renal disease or gastrointestinal dysfunction
- Had a frequency of exercise five or more days per week
- Currently pregnant
- Currently lactating.

Description of Study Protocol:

Recruitment

Overweight women were recruited from the surrounding community through newspaper advertising.

Design

Randomized, single-blind, crossover design.

Dietary Intake/Dietary Assessment Methodology

The crossover design consisted of two 27-day dietary feeding cycles separated by eight weeks of washout. During the period of washout, subjects consumed their habitual diets. Subjects were partial inpatients at the research unit during both feeding cycle periods. Subjects were allowed to leave the facility between meals for work or other approved purposes, but had to return to the unit after the evening meal and overnight. Meals were consumed under supervision at the unit. Also, under special circumstances, researchers allowed subjects to pack meals to consume outside of the unit.

Blinding Used

- Subjects were randomly allocated to receive one of two treatment sequences. Equal numbers of subjects were placed into groups
- Method of randomization was not specified.

Intervention

- Experimental diets consisted of prepared North American solid foods, precisely weighed and based on a three-day rotating cycle menu. Diets included three isoenergetic meals per day and provided 45% of energy as CHO, 15% as protein and 40% as fat
- Fat was accounted for in the following proportions:
    - 75% of the fat given was derived from the treatment fat and the remaining 25% was identical in both diets
    - The treatment fat was either functional fat (FctO) or beef tallow (BT) and incorporated directly into food items during meals preparation
    - Functional fat consisted of three major lipid components (MCT, phytosterols and n-3 PUFA)
    - The MCT component was comprised of MCT oil, butter and coconut oil
    - Phytosterols were administered at a concentration of 22mg per kg body weight per day
    - The *n*-3 PUFA was provided by flaxseed oil
    - Olive oil comprised 10% of the functional fat and provided monounsaturated fat to the mixture
    - The control diet was composed exclusively of beef tallow
- Nutrient intake was adjusted according to individual energy requirements of subjects which were determined using the Mifflin equation
- Body weight was monitored daily before breakfast during feeding periods
- No extra food was allowed between meals, except for decaffeinated, kcal-free carbonated beverages and herbal teas that were obtained from staff. One black coffee was allowed at breakfast.

Statistical Analysis

- Analysis of variance was performed using a mixed model procedure for repeated measures. Factors included phase, sequence, diet, time, time-by-phase interaction and time-by-diet

interaction. Age and initial body weight ware also tested as covariates. Paired Student's T-test was then applied to the model to compare time points within diet phases
- Sheffe's adjustment was performed to identity significant differences between the beef tallow and functional fat diets at corresponding times
- Separate comparisons between end points (a mean of days 26 and 28) were also performed in the mixed model
- The level of significance was set at $P<0.05$
- Version 8.0 of SAS software was used for all statistical analysis.

Data Collection Summary:

Timing of Measurements

- Intervention included two 27-day dietary feeding cycles separated by eight weeks of washout (during which subjects resumed their habitual diets)
- Fasting blood samples were collected on day one, 26 and 28 of each dietary feeding cycle
- Fecal samples (to measure fatty acid secretion) were collected for three days at midpoint during each feeding cycle.

Dependent Variables

- Analysis of fasting blood samples measured total cholesterol, plasma LDL, plasma HDL and triacylglycerol concentrations. Analysis of homocysteine, cysteinylglycien and glutathione were also measured form these samples
- Fecal samples were measured for fatty acid content
- Body weight was measured daily during feeding cycles at breakfast. Means of measurement were not specified.

Independent Variables

- Subjects were randomly assigned to receive one of two treatment sequences. Both diet treatments contained three isoenergetic meals per day.
- Meals provided 45% of energy as carbohydrate, 15% as protein and 40% as fat, of which 75% was delivered as treatment fat (functional fat or beef tallow).

Control Variables

- During feeding cycles, subjects ate meals at the research unit or were allowed to pack lunch meals provided by the unit staff during the day
- All subjects ate evening and morning meals at the unit and spent the night at the unit
- No extra foods were allowed between meals, except for decaffeinated, kcal-free beverages and herbal tees that were provided by unit staff. One black coffee was allowed per day.

Description of Actual Data Sample:

- *Initial N:* 22 females
- *Attrition (final N):* 17 subjects completed the study
- *Age:* 44±4 years
- *Other relevant demographics:*
    - Four subjects were smokers
    - Eight subjects were post-menopausal

- *Anthropometrics:*
  - Both groups were the same with a BMI of 32±1kg/m^2
  - Initial mean fasting total cholesterol and triacylglycerol concentrations were 5.12±0.17mmol per L and 1.57±0.14mmol per L, respectively
  - Initial energy and fat intakes were 2,458±73kcal per day and 109.25±3.25g per day, respectively
  - Baseline values of all variables were not statistically different between dietary phases
- *Location:* Mary Emily Clinical Nutrition Research Unit, McGill University, Ste-Anne-de-Bellevue, Quebec, Canada.

Summary of Results:

Effect of Experimental Diets on Plasma Lipid Concentrations

Plasma Lipid Parameter	Control Diet (Beef Tallow)	Functional Oil Diet (MCT, phytosterols, n-3 PUFA)
Total Cholesterol * (mmol per L)		
Baseline	4.77±0.17	4.58±0.21
Endpoint	4.80±0.20	4.37±0.20***
Change (%)	0.6	-4.6
LDL-cholesterol * (mmol per L)		
Baseline	2.76±0.12	2.66±0.15
Endpoint	2.86±0.20	2.39±0.15**,***
Change (%)	3.6	-10.2
HDL-cholesterol (mmol per L)		
Baseline	1.33±0.07	1.30±0.08
Endpoint	1.32±0.07	1.32±0.08
Change (%)	-0.8	1.5
HDL:LDL cholesterol ratio^		
Baseline	0.490±0.029	0.495±0.026
Endpoint	0.481±0.031	0.576±0.36**
Change (%)	-1.8	1.64
HDL:total cholesterol ratio&		
Baseline	0.279±0.012	0.281±0.010
Endpoint	0/276±0.010	0.304±0.012**
Change (%)	-1.0	8.2
Total triaclyglycerols (mmol per L)		
Baseline	1.48±0.12	1.36±0.15

Endpoint	1.37±0.13@±	1.42±0.012**
Change (%)	-7.4	4.4

*Significant main effect of diet, P<0.0001.

** Significantly different from baseline within dietary phase, P<0.05.

*** Significantly different from the control diet, P<0.05.

^ P<0.01.

# P<0.05.

@ Trend toward significant difference from baseline within dietary phase, P<0.1.

Fatty Acid Compostion of RBCs at Start and End of Experimental Diet Supplementations

Percent of Total Identified Fatty Acids	Control Diet (Beef Tallow)		Functional Oil Diet (MCT, Phytosterols, n-3 PUFA)	
	Day 1	Day 28	Day 1	Day 28
14:0[2]	0.34±0.03	0.26±0.02[2]	0.34±0.03	0.38±0.34[4]
16:0[2]	21.57±0.37	19.93±0.30[6]	21.15±0.41	21.19±0.44[4]
18:0	11.21±0.40	12.41±0.33[3]	11.13±0.45	11.48±0.43
18:1n-9	21.93±0.40	21.68±0.38	22.19±0.62	21.05±0.37[3]
18:2n-6	12.20±0.54	11.87±0.45	12.17±0.62	11.46±0.65
18:3n-3[7]	0.08±0.01	0.05±0.01[3]	0.08±0.01	0.18±0.02[6,8]
20:4n-6[9]	16.75±0.30	17.72±0.32[3]	16.16±0.41	16.60±0.37
20:5n-3[7]	0.84±0.4	0.66±0.06[10]	0.80±0.09	1.13±0.08[6,8]
22:4n-6[2]	3.51±0.17	4.18±0.24[3]	4.81±0.45	4.64±0.42
22:5n-3	3.84±0.15	3.76±0.19	3.72±0.17	4.00±0.19
22:6n-3	4.49±0.20	4.47±0.16	4.30±0.27	4.56±0.18
ΣSFA	33.11±0.37	32.60±0.47	32.62±0.55	33.05±0.67
ΣMUFA	22.81±0.41	22.41±0.41	22.94±0.60	22.04±0.40[3]

[2,7,9]Significant main effect of diet: [2]P<0.01, [7]P<0.0001, [9]P<0.05.

[5]Trend toward significant main effect of diet: P=0.0576.

[3,6,10]Significantly different from day one within dietary phase: [3]P<0.05, [6]P<0.0001, [10]P<0.01.

[4,8]Significantly different from the control diet at corresponding time points: [4]P<0.01,[8]P<0.001.

Author Conclusion:

- Consumption of medium chain triglycerides, combined with phyotsterols and alpha-linoleic acid, has a positive influence on the lipid profiles of healthy, overweight women
- The use of these dietary ingredients in combination can help to reduce health risks related to cardiovascular disease.

Reviewer Comments:

- *Authors reported that subjects did not like the taste of the control diet (beef tallow). This may have influenced total amount of food consumed*
- *No other limitation noted.*

Research Design and Implementation Criteria Checklist: Primary Research

Relevance Questions		
1.	Would implementing the studied intervention or procedure (if found successful) result in improved outcomes for the patients/clients/population group? (Not Applicable for some epidemiological studies)	Yes
2.	Did the authors study an outcome (dependent variable) or topic that the patients/clients/population group would care about?	Yes
3.	Is the focus of the intervention or procedure (independent variable) or topic of study a common issue of concern to nutrition or dietetics practice?	Yes
4.	Is the intervention or procedure feasible? (NA for some epidemiological studies)	Yes

Validity Questions		
1.	**Was the research question clearly stated?**	Yes
1.1.	Was (were) the specific intervention(s) or procedure(s) [independent variable(s)] identified?	Yes
1.2.	Was (were) the outcome(s) [dependent variable(s)] clearly indicated?	Yes
1.3.	Were the target population and setting specified?	Yes
2.	**Was the selection of study subjects/patients free from bias?**	Yes
2.1.	Were inclusion/exclusion criteria specified (e.g., risk, point in disease progression, diagnostic or prognosis criteria), and with sufficient detail and without omitting criteria critical to the study?	Yes
2.2.	Were criteria applied equally to all study groups?	Yes
2.3.	Were health, demographics, and other characteristics of subjects described?	Yes

2.4.	Were the subjects/patients a representative sample of the relevant population?	Yes
3.	**Were study groups comparable?**	Yes
3.1.	Was the method of assigning subjects/patients to groups described and unbiased? (Method of randomization identified if RCT)	Yes
3.2.	Were distribution of disease status, prognostic factors, and other factors (e.g., demographics) similar across study groups at baseline?	Yes
3.3.	Were concurrent controls used? (Concurrent preferred over historical controls.)	Yes
3.4.	If cohort study or cross-sectional study, were groups comparable on important confounding factors and/or were preexisting differences accounted for by using appropriate adjustments in statistical analysis?	N/A
3.5.	If case control or cross-sectional study, were potential confounding factors comparable for cases and controls? (If case series or trial with subjects serving as own control, this criterion is not applicable. Criterion may not be applicable in some cross-sectional studies.)	N/A
3.6.	If diagnostic test, was there an independent blind comparison with an appropriate reference standard (e.g., "gold standard")?	Yes
4.	**Was method of handling withdrawals described?**	Yes
4.1.	Were follow-up methods described and the same for all groups?	Yes
4.2.	Was the number, characteristics of withdrawals (i.e., dropouts, lost to follow up, attrition rate) and/or response rate (cross-sectional studies) described for each group? (Follow up goal for a strong study is 80%.)	Yes
4.3.	Were all enrolled subjects/patients (in the original sample) accounted for?	Yes
4.4.	Were reasons for withdrawals similar across groups?	Yes
4.5.	If diagnostic test, was decision to perform reference test not dependent on results of test under study?	Yes
5.	**Was blinding used to prevent introduction of bias?**	Yes
5.1.	In intervention study, were subjects, clinicians/practitioners, and investigators blinded to treatment group, as appropriate?	Yes
5.2.	Were data collectors blinded for outcomes assessment? (If outcome is measured using an objective test, such as a lab value, this criterion is assumed to be met.)	Yes
5.3.	In cohort study or cross-sectional study, were measurements of outcomes and risk factors blinded?	N/A

5.4.	In case control study, was case definition explicit and case ascertainment not influenced by exposure status?	N/A
5.5.	In diagnostic study, were test results blinded to patient history and other test results?	Yes
6.	**Were intervention/therapeutic regimens/exposure factor or procedure and any comparison(s) described in detail? Were interveningfactors described?**	Yes
6.1.	In RCT or other intervention trial, were protocols described for all regimens studied?	Yes
6.2.	In observational study, were interventions, study settings, and clinicians/provider described?	N/A
6.3.	Was the intensity and duration of the intervention or exposure factor sufficient to produce a meaningful effect?	Yes
6.4.	Was the amount of exposure and, if relevant, subject/patient compliance measured?	Yes
6.5.	Were co-interventions (e.g., ancillary treatments, other therapies) described?	N/A
6.6.	Were extra or unplanned treatments described?	N/A
6.7.	Was the information for 6.4, 6.5, and 6.6 assessed the same way for all groups?	Yes
6.8.	In diagnostic study, were details of test administration and replication sufficient?	Yes
7.	**Were outcomes clearly defined and the measurements valid and reliable?**	Yes
7.1.	Were primary and secondary endpoints described and relevant to the question?	Yes
7.2.	Were nutrition measures appropriate to question and outcomes of concern?	Yes
7.3.	Was the period of follow-up long enough for important outcome(s) to occur?	Yes
7.4.	Were the observations and measurements based on standard, valid, and reliable data collection instruments/tests/procedures?	Yes
7.5.	Was the measurement of effect at an appropriate level of precision?	Yes
7.6.	Were other factors accounted for (measured) that could affect outcomes?	Yes
7.7.	Were the measurements conducted consistently across groups?	Yes
8.	**Was the statistical analysis appropriate for the study design and type of outcome indicators?**	Yes
8.1.	Were statistical analyses adequately described and the results reported appropriately?	Yes

8.2.	Were correct statistical tests used and assumptions of test not violated?	Yes
8.3.	Were statistics reported with levels of significance and/or confidence intervals?	Yes
8.4.	Was "intent to treat" analysis of outcomes done (and as appropriate, was there an analysis of outcomes for those maximally exposed or a dose-response analysis)?	Yes
8.5.	Were adequate adjustments made for effects of confounding factors that might have affected the outcomes (e.g., multivariate analyses)?	Yes
8.6.	Was clinical significance as well as statistical significance reported?	Yes
8.7.	If negative findings, was a power calculation reported to address type 2 error?	N/A
9.	**Are conclusions supported by results with biases and limitations taken into consideration?**	Yes
9.1.	Is there a discussion of findings?	Yes
9.2.	Are biases and study limitations identified and discussed?	Yes
10.	**Is bias due to study's funding or sponsorship unlikely?**	Yes
10.1.	Were sources of funding and investigators' affiliations described?	Yes
10.2.	Was the study free from apparent conflict of interest?	Yes